logical optics had not yet entered upon the high career to which it has since been brought, and what in 1826 was only dimly understood, was in 1856 by Helmholz, and in 1864 by Donders, brought to the light of perfect demonstration.

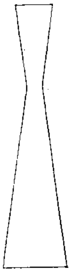
NEW YORK, 73 Madison Avenue.

ART. IV.—*Observations on the Eustachian Tubes, with Description of an Instrument for their penetration by Rhinoscopy.* By EPHRAIM CUTTER, M.D., of Woburn, near Boston, Mass. (With four wood-cuts.)

ACCORDING to Tröltsch most anatomists suppose the Eustachian tubes to be the remains of the first embryonal bronchial fissure, probably because they are compound structures, being composed of membrane, cartilage, and bone. The average length (Tröltsch) is about 1½ inches, or, more accurately, 35 millimeters, of which 24 belong to the cartilaginous and 11 to the osseous portion.

At the pharyngeal orifice it is 9 mm. in height, in breadth 5 mm. At the tympanic orifice it is 5 mm. in height, in breadth 3 mm. At the inner end of the cartilaginous portion it is 2 mm. high, and 1 mm. wide. Thus the Eustachian tube is not uniformly cylindrical, but slightly trumpet-shaped at both ends, or rather two frustrums meeting at their narrow extremities; *vide* Fig. 1, which represents an outline of the tube according to the above measurement of Tröltsch. An Eustachian tube which the writer removed from a dissecting-room subject, aged eighty years, presented a uniformly cylindrical appearance, much different from that stated by Tröltsch.

Fig. 1.



The constituent parts are not diffused equally throughout the whole calibre. The cartilage composes about two-thirds of the tube which lies toward the pharyngeal orifice. This two-thirds is disposed on the posterior part of the tube. It is a thin lamina, difficult to separate by dissection. The remaining third of the tube is membranous. This disposition of cartilage is analogous to that in the trachea. The evident object is to secure a patency of the tube.

The membrane of the inside is corrugated in the direction of the long axis of the tube. It is covered with ciliated epithelium.

The position of the faucial end of the Eustachian tube is described to be opposite the middle turbinated bone. When it is known that in some cases a rhinoscopic examination shows *an entire absence of the middle turbinated bone,* the accuracy of this statement may well be questioned. The fact is that the Eustachian orifice opens at different points in different subjects. Sometimes, as in the writer's case, it is found to be opposite the upper and outer quarter of the posterior nasal openings. Sometimes it is opposite the middle, and sometimes opposite the lower quarter. Thus Fig. 2 shows this variety in position.

Fig. 2.

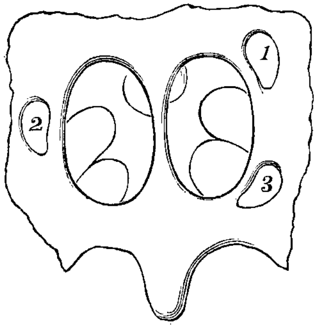
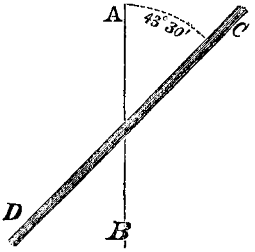


Diagram of the Posterior Nares, looking from within outwards: 1. Is the position of the Eustachian orifice in the writer's case; 2. Is the second position named; 3. Is last position. *Vide* Mackenzie on the Laryngoscope, edited by Dr. J. Solis Cohen, Philada. ed., 1869, p. 282.

With this variety of position how can rules given for the introduction of the Eustachian catheter through the nose be definite? Why not call in the aid of the rhinoscope, and ascertain the situation of the orifice before attempting a catheterization? Otherwise it is guess-work; an inexact procedure, unworthy of the present state of our knowledge.

The direction of the Eustachian tubes is generally described as from within outwards, backwards, and upwards. In order to give more definiteness to this description, the writer measured the angle which the Eustachian tube makes with the antero-posterior vertical median plane of the head. One of the cases was in a specimen in the Warren Anatomical Museum, from a child eighteen months of age, access to which was kindly given by Prof. Jackson, curator. A straight probe was thrust into the Eustachian tube and held there by contact. A large portion of the probe projected. The half head was then held over a straight line marked on a piece of paper in such a manner as that the vertical surface corresponded with the line. The points where the projecting probe covered the line, and where it terminated over the paper were marked. On connecting these two points with each other by a pencil-mark, the angle of obliquity was given. This was subsequently measured on a tractometer (an instrument for measuring angles), and was found to be 43° 30′. *Vide* Fig. 3.

Fig. 3.



C D represents the antero-posterior median line of a vertical section of the head. *A B* is the probe marking the direction of the Eustachian tube. The angle represents the obliquity of the tube.

The other case of admeasurement was in a dissecting-room subject, female, 82 years of age, through the kindness of Dr. John W. Mead, of Lowell. The obliquity was the same as in the first case. So that probably one would be safe in saying that the direction of the Eustachian tubes is in the neighbourhood of 45° backwards. In the cases measured there was no upward direction as the probe stood horizontally. The writer wishes that observers would measure this angle on different subjects as they have opportunity, and report the same, even if it is only *one* observation. It is only by multiplied scrutinizations that general laws can be laid down. A report must not be despised because it involves only a *single* instance, because experience is but an aggregation of single events. If the integral parts are withheld there can be no whole.

The question of the patency of the faucial Eustachian orifices is a vexed one. The majority of observers maintain that they are closed *except* during the act of deglutition. We coincide with the view *that they are always open normally,* contrary to what we have before advanced (*Vide Boston Med. and Surg. Journal,* Feb. 1867), "That they are always open except during the act of deglutition."

The following considerations are adduced in support of this position: 1st. The anatomical characters of the tube; 2d. The physiology; 3d. Actual observation.

The *anatomical characters* of the tube we have seen are bony towards the tympanic end; that certainly cannot close, except by being filled up from the inside. This would not be a physiological, but a pathological condition. The remaining portion is partly bony, partly cartilaginous, and partly membranous; so much so that it is impossible to conceive of any contact of the internal walls, except at the pharyngeal orifice. This is more apparent when we consider that the membranous portion of the Eustachian tube occupies only one-third of the circumference. To close up the tube would require the collapse of this membrane, and the bending together of the cartilage; so that the inverted membrane should fill up the space embraced within the concavity of the cartilaginous walls. But the cartilage and the membrane are attached to the surrounding parts, so that the amount of inversion required, which is very considerable, cannot be accomplished. The trachea, which is about two-thirds cartilage and one-third membrane, does not collapse and its walls come in contact during physiological acts. Neither does the meatus auditorius externus, composed of cartilage and bone, ever collapse physiologically. The nostrils are analogous in structure as to bone, membrane, and cartilage, they close only by voluntary act physiologically.

The other orifices in the body that are known to close and open, such as the oral, anal, puncta lachrymalia, urethral, vaginal, œsophageal, stomachic, ileo-cæcal, &c., have anatomical characters not resembling those of the Eustachian tubes. Anatomical structure and analogy point to the function of the Eustachian being always open normally.

The physiology. It is generally believed that the most important of the functions of the Eustachian tube is to maintain a communication between the internal ear and the external atmosphere. Were the internal ear a closed cul-de-sac, the vibrations of the tympanum would be deadened. If the internal ear, besides being a closed cul-de-sac, were a vacuum, the delicate tympanum would be distended inwards, if not ruptured, by the atmospheric pressure of fifteen pounds to the square inch. It seems to have been the design of the Creator to bury the organs of hearing, which are of exquisite sensibility, deep in a bony cavity, out of the way of harm, and yet so sensitive to the vibrations of the outside air that they are capable of detecting vibrations which play over one thousand times a second!

Now, if the Eustachian tubes did not afford the communication to the outside atmosphere, it is difficult to understand how the function of hearing could be performed at all. Indeed, when the Eustachian tubes are closed, for example by inflammation, its processes, or results, this closure is a sufficient cause for the deafness which results. Now, if the Eustachian tubes are closed *except* during the act of deglutition, would we not expect that deafness would exist except during a meal? Or, if we take the other proposition, one which the writer formerly maintained, namely, that the Eustachian tubes are *closed only during the act of deglutition*, should we not expect a momentary deafness while deglutition was performed?

It was by observing that there was no deafness or occlusion of hearing during the act of swallowing, that the writer has been led to review his position, and to maintain that the Eustachian tubes *are open at all times during normal condition.*

Another function is the affording a canal whereby egress may be found from the internal ear for secretions which form therein, and if retained would mechanically distend and interfere with the function of the internal ear. I doubt whether there are any such secretions *normally;* abnormally they may occur. Whenever they do exist, would they not be discharged better through Eustachian tubes permanently open, than through canals generally shut? So that the function of affording egress favours a patent condition of the tubes.

The Eustachian tubes being at all times open, allows of the introduction of air by diffusion; as in the lungs, the air penetrates the cells at the extremities and sides of the terminal bronchial divisions. The cavity of the tympanum is a closed cul-de-sac. The vibrations of the tympanum and motions of the ossicles cannot exclude all the air, as they are not extensive enough. We are left to fall back upon diffusion as a sufficient and satisfactory cause of the change of air in the cavity.

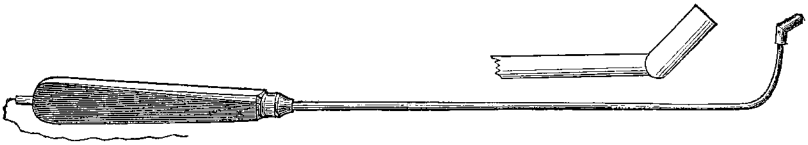
Take the simple Valsavian experiment, which "consists in pressing the air into the ear, after a powerful inspiration, the mouth and nose being closed." When the organs are healthy the air is pressed and condensed into the cavity of the tympanum, and the tympanum stretched, and is forced outwards, as appears by inspection and subjective sensations. On the other hand, if the mouth and nose are closed, and the air exhausted by sucking and swallowing, the tympanum is stretched inwards. Moreover, if the tympana are absent or perforated, the air rushes out with an audible noise, and water injected into the meatus externus passes freely into the throat. Now, on the supposition that the tubes are closed except during the act of deglutition, it is difficult to conceive how the air could so easily distend the drums in the Valsavian experiment, or the water pass in the other. If the other supposition, that the tubes are open *except* during deglutition, it is also difficult to reconcile the facts, as during the Valsavian experiment the soft palate is drawn up against the post-pharyngeal wall, crowding, if anything, the Eustachian orifices together towards closure. On the supposition that the tubes are open at all times normally, it is easily seen how air and water can be sucked from or forced and injected through against the air which is in the cavity of the tympanum.

Observations by the rhinoscope favour at first sight the view that the tubes are closed during deglutition. A partial narrowing is seen of the outlet as the soft palate is drawn up by the tensor palati muscles, but as the palate approaches close to the post-pharyngeal wall it obscures the view, so that it is impossible to tell from inspection how the orifices appear when the palate has made its complete air-tight fit against the post-pharyngeal wall. The writer has examined his own and other Eustachian orifices repeatedly, and they always have been found to be open, in what was considered a healthy condition. Dr. L. Elsburg, of New York city, takes the view that the Eustachian tubes are closed by a contact of their inner parietes; that this closure is not tight, but loose. He compares the contact to that of the vaginal walls in healthy females. Air forced easily passes, as the obstruction is so slight. So that practically the tubes are always open. I am obliged to dissent from this view, although its results are the same as mine. On the other hand, in some cases of deafness he has found a closed condition of the orifices. So that on the view that a patency of the Eustachian tubes is their normal condition, it has occurred to him to suggest a means of penetrating them with air or otherwise.

Taking the ground that the Eustachian tubes do not always open into the pharynx at the same points, as shown before, it is deemed advisable, when possible, to make a rhinoscopic examination, and find out where they are placed and what is their condition; then, bearing in mind the direction of the Eustachian tubes, as before described, to approach them from the mouth with a catheter, which is a simple brass or silver tube, eight inches long, three-sixteenths inch in diameter, provided with a handle at one end, and at the other bent up to a right angle for about one inch. This instrument brings one to the *mouth* of the Eustachian tubes. To enter these tubes by air, for instance, another piece of tube similar in size and material, $\frac{1}{4}$ inch in length, is soldered at a right angle to the long axis of the terminal branch of the tube. At the same time it is placed forwards to the left, if for the right Eustachian tube, at an angle of 43°, with a vertical plane running through the long axis of the instrument. If intended for the left Eustachian tube the terminal bar is placed on the right.

To recapitulate, it will be seen that this instrument follows mechanically the directions into the Eustachian tubes from the mouth, viz.: 1st. The long axis follows that of the mouth; 2d. The bent portion follows the long axis of that part of the pharynx behind the soft palate; and 3d. The terminal bar follows the angles which the Eustachian tubes make with the pharynx.

Fig. 4.



Eustachian Catheter of the writer.

To use this catheter it is necessary to ascertain the position of the Eustachian orifices by means of the rhinoscope. The catheter, flat side parallel to the tongue, is passed just behind the velum palati. A quarter turn will bring the end uppermost without touching the uvula or palate. Then by means of the reflection in the mirror, the terminal end is brought into contact with, and buried in, the Eustachian orifice desired. All these procedures being done under sight, there can be no question but that the instrument is fairly engaged in the tube. Air or water, or atomized liquids, may then be easily forced into the tube, as deemed advisable by the operator. Air may be blown from the operator's mouth by means of an India-rubber tube, which is slipped over the proximal end of the catheter.

In order to introduce tents into the tubes, a modification of this catheter is necessary. Instead of having the terminal bar soldered on, it is provided with a socket which fits on, and allows of motion in a circle about the end. A small hole is bored through the socket, and a fine wire is passed through and knotted. The other end of the wire is drawn through the tube and brought out beyond and bent up towards the handle. The object of this wire is to hold the socket in place during introduction and rotation. If it is desired to introduce a slippery-elm tent, for instance, the process is as follows: A piece of slippery elm 1$\frac{1}{8}$ inch in length is fitted into the cavity of the terminal branch, so that about one inch projects. This portion is rounded, pointed, and moistened with water. It then becomes very slippery. The fine wire is drawn tight and fastened about the handle. If the tent is set at the angle of 43°, it is easily seen that it cannot be introduced, as the point projects too far forward to get safely under the soft palate. It is necessary to set the tent at an angle of 90° with the vertical plane of the instrument. It is then introduced into the pharyngeal cavity, as described; except that just before the point of the tent reaches the soft palate it is depressed behind the tongue until the point clears the velum, and the upward turn is made, which brings it behind and lying parallel to the velum. A sidewise movement brings the point to the Eustachian orifice, and continued engages it and the tent in the tube—the tent rotating from the angle of 90° to that of 43° as it progresses in the penetration. If desired, the tent and terminal branch and wire may be disengaged and left in. The wire serves as a means of communication, and preventive of swallowing the tent, should it chance to become disengaged and drop out.

There should be one catheter for the right and one for the left.

ART. V.—*On Hectic Fever.* By FRANCIS D. CONDIE, M.D., of Philadelphia.

Is hectic fever to be considered an essential, pathognomonic feature of pulmonary phthisis? Few physicians, we suspect, called to a patient who, after a lingering illness, has become, gradually, greatly emaciated, with a quick and feeble pulse, who is daily subject to attacks of chilliness, more or less marked, followed by flushings of heat, a dry, parched skin, circumscribed redness of both cheeks; one such paroxysm of chilliness occurring in the twenty-four hours, between two and three o'clock of the afternoon, or, not unfrequently two, the second occurring just before night-fall, both paroxysms terminating—the one during the early portion of the night, the other towards morning—in a copious, clammy, and exhausting perspiration; few physicians, we repeat, observing in a patient such a group of symptoms, especially if, in addition, there is short, impeded respiration, frequent cough, with expectoration, would not pronounce him or her to be labouring under tuberculosis of the lungs, and in a large number of cases his diagnosis would be perfectly correct.

The symptoms above described, taken in connection, are unquestionably those most usually observed in patients labouring under pulmonary consumption, especially in the protracted stage of the disease.

Hectic fever, however distinctly developed, is by no means pathognomomic of pulmonary tuberculosis, even when accompanied by impeded or disturbed respiration, cough and expectoration. Such a group of symptoms mark, usually, cases of spurious consumption (chronic bronchitis and pneumonia), while hectic fever is the attendant upon a large number of cases of disease in which no affection of the respiratory organs is present, as is proved by repeated post-mortem examinations. In the course, in fact, of any disease, in exhausted patients in whom there exists a chronic source of irritation, hectic fever is liable to be, is, indeed, generally developed.

Though a common attendant upon pulmonary tubercular phthisis, yet it is not so invariably, and, consequently, is not pathognomonic of that form of disease. According to Louis its presence will be found wanting